Laughing away the pain: A narrative review of humour, sense of humour and pain

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Abstract: Background and Objective: The link between humour and sense of humour with pain has been a topic of research for decades. The purpose of the present article was to review the different studies that have been conducted to date on the association between humour and sense of humour with pain. Databases and Data Treatment: The literature search was conducted using the PubMed, Science Direct and ProQuest databases. Forty-one studies were reviewed, and the results are summarized and structured into three sections: experimental pain, chronic pain and pain in children. Results: For experimental pain, the findings support the idea that humorous distractions, such as watching a comedy clip, increase pain tolerance, although most of the studies indicate that other non-humorous distractions produce similar effects. Regarding chronic pain, humour has been studied as a way of coping with pain and the emotional distress produced by chronic pain conditions. The results of correlational studies show significant associations between the use of humour and main variables such as anxiety and catastrophizing. Finally, concerning pain in children, similar findings to those described for the previous sections have been reported, with a notable presence of studies on clinic clown interventions, which promote emotional well-being among children and their parents, although their effectiveness in pain reduction is controversial. Conclusions: The study of the link between humour and pain is still on an early stage, and overcoming the limitations of previous studies is required to strengthen the promising results that have been observed up to date. Significance: This review summarizes all main findings regarding humour, sense of humour and pain up until the first half of 2018 and offers a list of aspects to be considered in further studies regarding the link of humour and pain to contribute to a more systematic research.

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Laughing Away the Pain: A Narrative Review of Humor, Sense of Humor, and Pain

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Abstract

Background and Objective. The link between humor and sense of humor with pain has been a topic of research for decades. The purpose of the present article is to review the different studies that have been conducted to date on the association between humor and sense of humor with pain.

Databases and Data Treatment. The literature search was conducted using the PubMed, Science Direct, and ProQuest databases. Forty-two studies were reviewed and the results are summarized and structured into three sections: experimental pain, chronic pain, and pain in children.

Results. For experimental pain, the findings support the idea that humorous distractions, such as watching a comedy clip, increase pain tolerance, although most of the studies indicate that other non-humorous distractions produce similar effects. Regarding chronic pain, humor has been studied as a way of coping with pain and the emotional distress produced by chronic pain conditions. The results of correlational studies show significant associations between the use of humor and main variables such as anxiety and catastrophizing. Finally, concerning pain in children, similar findings to those described for the previous sections have been reported, with a notable presence of studies on clinic clown interventions, which promote emotional wellbeing among children and their parents, although their effectiveness in pain reduction is controversial.

Conclusions. The study of the link between humor and pain is still on an early stage, and overcoming the limitations of previous studies is required to strengthen the promising results that have been observed up to date.

Keywords: humor, sense of humor, pain, laughter, clinic clown interventions

What does this study add?

The present review is the first comprehensive report on the main findings of the studies conducted on the topic of the link between humor, sense of humor, and pain in its diverse forms. This review has a more specific focus than previous ones such as Martin's (2004), which studied sense of humor and physical health more broadly. Thus, the current review has a detailed focus on pain, as well as including all findings up until the first half of 2018.'

This review offers a list of aspects to be considered in further studies regarding the link of humor and pain to contribute to a more systematic research on this topic.

1. Introduction

Humor has long been considered as helpful to people in adapting to life stressors, and many researchers have devoted their attention to it. Among all the different topics that have been studied in the field of humor, pain deserves to be granted a high importance as any contribution addressed to treat pain and its associated symptoms is of the highest clinical relevance. Humor has been described as one of the possible ways to react to pain, framed in the behavioral endurance strategies next to pain persistence (Hasenbring, Hallner, & Rusu, 2009). For decades, researchers have designed experiments to study how can humor modify pain perception, and some have studied its effects on pain-related variables such as quality of life. Nonetheless, the results need to be considered with caution, as the studies often present some methodological issues (Martin, 2004). Thus, the purpose of this review is to expose the knowledge that scientists have collected during decades, remarking those findings which are supported by strong evidence and pointing out which are their shortcomings, and suggesting some future directions which researchers willing to deepen into the topic of humor and pain could consider. In this review, we aim at answering the following questions: can the perception of pain be altered by the exposure to a humorous stimulus? If so, is it a neurobiological response or just distraction what produces the effect? Can humor interventions really improve quality of life in people suffering chronic pain? Would the previous questions have a different answer if we talk about children? To facilitate the understanding of the results, and considering the complexity of the topic we are reviewing, we will present a comprehensive introduction about humor terminology and theoretical frames before presenting the main findings and conclusions of our work.

1.1 Humor terminology

Humor is a complex phenomenon which involves cognitive, emotional, behavioral, psychophysiological and social aspects (Martin, 2000). On the cognitive axis, humor is related to a perception of incongruity or paradox in a playful context (Forabosco, 1992); emotionally, it is associated with a pleasant emotional state which has been described as "exhilaration" (Ruch, 1993); in terms of psychophysiology, it has been asserted that it is associated with reductions in cortisol, growth hormones, and epinephrine (Berk et al., 1989); and as a social phenomenon, humor plays an important role in interpersonal communication and attraction (Murstein & Brust, 1985).

Although very related to humor, *sense of humor* is a different construct which refers to *"habitual individual differences in all sorts of behaviors, experiences, affects, attitudes, and abilities relating to amusement, laughter, jocularity, and so on"* (Martin, 1998, p. 17). It has been conceptualized in different ways (Martin, Puhlik-Doris, Larsen, Gray, & Weir, 2003): as a cognitive ability (e.g., ability to create, understand, remember and reproduce jokes; Feingold & Mazzella, 1993); as an aesthetic response (e.g., humor appreciation, enjoyment of particular types of humorous material; Ruch & Hehl, 1998); as an habitual behavior pattern (e.g., tendency to laugh frequently, to tell jokes and amuse others, to laugh at others' jokes; Craik, Lampert, & Nelson, 1996; Martin & Lefcourt, 1984); as an emotion-related temperament trait based on cheerfulness, seriousness and bad-mood (Ruch, Köhler & van Thriel, 1996, 1997) or on motivational aspects (telic vs. para-telic; Apter, 2013); and as a coping strategy or defense mechanism (e.g., tendency to maintain a humorous perspective in the face of adversity; Lefcourt & Martin, 1986). Other lists are even more elaborate underscoring the complexity of humor (Hehl & Ruch, 1985). While factor analytic studies helped reduce this complexity, there is no comprehensive model of humor yet that would allow incorporating each important facet and hence make accumulative research possible.

Therefore, while humor may be viewed as an umbrella term for everything potentially funny, or laughable (Martin, 2010), sense of humor denominates the humor within a person. The sense of humor is subject to individual differences and various authors have put forward alternative conceptualizations (i.e., facets, habits, styles). For instance, Martin et al. (2003) defined four general types of humor style: (1) *affiliative humor*, which consists of laughing, using jokes and telling funny stories to affirm oneself and others; (2) *aggressive humor* refers to humor that is impulsive and derisive toward others such as sarcasm, teasing, and ridicule; (3) *self-enhancing humor*, which is used for maintaining an optimistic look on life when stressful events arise, so it could also be considered as the coping type of humor; and (4) *self-defeating humor*, which consists of allowing oneself to be the

butt of jokes to gain others' approval. It has been claimed that both affiliative and self-enhancing humor are associated with positive outcomes such as cheerfulness, self-esteem, intimacy, relationship satisfaction, and predominant positive moods; on the other hand, aggressive and self-defeating humor present links with neuroticism, stress, anger, depression and anxiety, low self-esteem, and negative moods (Martin et al., 2003; Richards & Kruger, 2017). Nonetheless, both self-enhancing and self-defeating humor styles have been found to be more associated with happiness than the other-directed humor styles (Cann, Stilwell, & Taku, 2010; Ford, McCreight, & Richardson, 2014). It should be noted that some studies suggest limited construct validity of the self-defeating humor style (Heintz, 2017; Ruch & Heintz, 2013).

Another important distinction to draw is between humor and laughter. While early studies often used them as synonyms (see Ruch & Hofmann, 2017 for an overview), the two are not the same; individuals can experience something as funny (and would feel amused) without any kind of facial expressions at all, mild smiles, or laughter. This might be seen as a function of personality (i.e., individuals with higher scores in extraversion or trait cheerfulness tend to laugh at less funny stimuli than less extraverted or cheerful counterparts (see Hofmann, Platt, Ruch, Niewiadomski, & Urbain, 2015; Ruch, 2005) and as a function of emotional intensity (see Hofmann, Platt, & Ruch, 2017; Ruch, 1993). Moreover, laughter has various elicitors and functions beyond humor (i.e., conversational functions, emotional elicitors; see Ruch, Hofmann, & Platt, 2013).

1.2 Theoretical frameworks

Different hypotheses have been described over recent decades regarding the effects of using humor as a coping strategy and being exposed to humorous stimuli while experiencing pain. Pain is a distressing sensation that can occur acutely or chronically; acute pain is defined as the normal physiological response to an adverse chemical, thermal or mechanic stimulus associated with surgery, trauma, and acute illness (Carr & Goudas, 1999). Chronic pain, on the other hand, refers to pain in one or more parts of the body that persists for more than three months and is associated with mental and emotional problems or disabilities in daily functioning, as well as participation in social activities (Treede et al., 2015).

Figure 1 presents a summary of the main theoretical frames, which could be classified into biological and psychological. The first one was developed in the early 1990s, when some authors considered that the exposure to humorous stimuli could improve health outcomes by producing

alterations in biological parameters associated with pain. This hypothesis was explored in a couple of empirical studies with promising results, but this line of research was not carried forward extensively in the following years. Also from a biological perspective, yet in combination with psychological aspects, some other authors theorized that an adaptive humor style may affect health through positive emotional states that are generated by it, which may have analgesic (Bruehl, Carlson, & McCubbin, 1993) and immuno-enhancing effects (Stone, Cox, Valdimarsdottir, Jandorf, & Neale, 1987) or may even undo the cardiovascular sequelae of negative emotions (Stafford, 2004).

From psychology's perspective, some authors have hypothesized that being exposed to humorous stimuli or tasks may impact on health due to the *distraction* that comes with it (Auerbach, Hofmann, Platt, & Ruch, 2014; McCaffery, 1990; Trent, 1990). Importantly, distraction has been shown to be an effective strategy for dealing with pain (Feldman, Downey, & Schaffer-Neitz, 1999). According to Johnson (2005), distraction from pain works in terms of competition between exogenous and endogenous information processing; the perception of the endogenous stimulus (pain) is suppressed by consciously focusing attention on a non-pain stimulus. Another theory is that humor can be used as a mechanism for cognitive reappraisal of stressful events, which consequently promotes resilience and well-being (Kuiper, 2012). Using humor enables individuals to view stressful situations as challenges rather than threats and thereby gain a sense of mastery over the event (Cann & Collette, 2014; Dozois, Martin, & Bieling, 2009). In addition, humor as a coping strategy can help to distance oneself from the emotional impact of an event and refocus on its positive aspects (Fritz, Russek, & Dillon, 2017; McGhee 2010). Thus, in this case, humor would help individuals to reappraise pain in retrospect as less negative and stressful. Finally, a group of theoretical accounts considers that the health benefits of humor may be mediated by social support, meaning that people who use adaptive forms of humor and a benevolent sense of humor may initiate and sustain friendships more easily. They may be more socially competent and this could enable them to achieve more satisfying social relationships (Bell, McGhee, & Duffey, 1986), which in turn has been proved to be another aspect of relevance in coping with pain (Sturgeon & Zautra, 2016).

2. Literature search methods

Articles were identified using keyword database searches and then snowballing from the reference lists of the relevant articles identified. The PubMed, Science Direct, and ProQuest databases were searched using the terms 'humor', 'laughter', and 'pain'. Additionally, key words were supplemented via a 'snowball method' in which references from relevant articles were reviewed and selected to find other studies. Searches were limited to peer-reviewed studies and articles published in English or Spanish. The search was not restricted by year of publication.

The 529 articles identified in the searches were screened for relevance by title, reducing the list to 82 articles. After removing 25 duplicates, the remaining 57 articles were screened by abstract, including only those in which humor or sense of humor had been studied in relation to pain, whether they were cross-sectional or experimental studies. This led to a final list of 41 articles which are structured in three sections: humor and experimental pain (13), humor and chronic pain (15), and humor and pain in children (13). Supplementary Table presents a comprehensive description of the studies that have been included in the present review.

3. Humor, sense of humor and pain: experimental findings and clinical evidence

3.1 Humor and experimental pain

Experimental pain is a type of acute pain which is produced artificially in experimental conditions using methods such as the cold pressor test (CPT), transcutaneous end nerve stimulation, or ischemic pain induced by a blood-pressure cuff (Zweyer, Velker, & Ruch, 2004). Although some studies have assessed the effect of humor on experimental pain using clinical samples, most have typically been conducted on general populations. These studies normally used pain threshold, pain tolerance and pain sensitivity as outcome measures (Zweyer et al., 2004).

The first studies designed to assess the link between humor and experimental pain examined the effect of the exposure to a humorous clip or audiotape on pain threshold and tolerance. Cogan, Cogan, Waltz and McCue (1987) conducted the first experiments to test this effect, and observed that laughter increased the participants' pain threshold significantly (F= 3.55, p< .05) in a sample of 40 undergraduate students. They underlined the spontaneous nature of laughter in comparison to other methods for reducing pain sensitivity such as relaxation, which usually need certain training. A posterior study replicated this experiment (Nevo, Keinan & Teshimovsky-Arditi, 1993) in a sample of 72 undergraduate students, but in this case, no differences were found for the humorous stimuli in comparison to the control conditions (i.e. documentary film, and no film group), although a significant moderate correlation (r= .38, p= .033) between the funniness ratings given to the film and the pain tolerance duration was found. The moment of exposure to the humorous stimuli (i.e. before or during the experiment), the types of humor to which the participants were exposed, and the pain-related variables measured (i.e. threshold vs. endurance) could explain the divergent results of these two studies (Nevo et al., 1993).

In this regard, Rotton & Shats (1996) concluded that humorous films may have an aversive effect on pain tolerance if the movie does not match one's humor preference. The experiment, conducted with 78 post-operative patients, found that those who chose to watch a humorous film over a serious one, if combined with positive expectations on pain reduction, requested less minor medication in the two days following surgery (F= 6.37, p< .05). Curiously, when the humorous film was the only viewing option, patients increased self-administration of analgesia (F= 4.72 p< .05), which seems to indicate that being able to choose what to watch was an important factor in enjoying the film and, thus, increasing pain tolerance.

It could be argued that the results found in this study regarding the effect of the humorous clip when compared with the serious one could be due to patients' particular personal characteristics (e.g., a certain personality, humor style) which led them to choose one or the other, and thus, these variables -and not the humorous stimulus- could be responsible for the effect. In this regard, a later study (Mahony, Burroughs, & Hieatt, 2001) conducted a similar experiment with 134 undergraduate students and measured both the role of expectations regarding the effect of humor on discomfort thresholds and of the humorous personality trait, measured with the Sense of Humor Questionnaire (SHQZ; Ziv, 1981). They found that a relaxing clip and a humorous one increased the discomfort threshold, and that this effect was enhanced by expectations in both cases (F= 9.84, p= .002). On the other hand, humorous personality trait presented no significant association with changes in discomfort threshold.

Further studies focused their research not just in assessing if exposition to humorous stimuli could modify pain perception but also in giving answer to what mechanisms may explain this observed effect. To test whether the effect of humor on pain tolerance was due to distraction mechanisms, some researchers designed experiments to determine whether humorous tasks, such as watching comedy clips, had a greater effect on pain tolerance than other distracting tasks. Weisenberg, Raz, and Hener (1998) compared the effects of watching a humorous film with those produced by watching a sad film and observed that the humorous film had more positive effects (F= 3.34, p= .003), thus they concluded that humor and laughter may induce physiological changes that may take some time to develop. However, different results have been reported, as other studies have found that dramatic and sad films had a similar effect on pain tolerance (Weaver & Zillmann, 1994; Weisenberg, Tepper, & Schwartzwald, 1995; Zillmann, Rockwell, Schweitzer, & Sundar, 1993), including a recent one conducted on 90 post-surgical patients (Elmali & Balci Akpinar, 2017). Similarly, Mitchell, MacDonald and Brodie (2006), who performed an experiment with 44 undergraduate students using the CPT as pain-inducing method, found that pain tolerance was similar

when the distracting task consisted of listening to music, listening to a humorous tape, or doing an arithmetic task. Both music and humor were significantly more successful at distracting attention from experimental pain than the arithmetic task ($p < .01$), and preferred music was reported to provide a greater feeling of control over a painful experience than a humorous distraction ($p < .05$, $d = .24$). Notably, the authors recognize that one limitation of the study was that the participants were not given the choice of what humorous tape to listen to, while they could choose their music. As commented on previously, being able to choose seems to be a relevant part of the effect of humorous distractions (Rotton & Shats, 1996). Considering all these results, in which humorous stimuli have not achieved significant effects compared to other distractors ($p > .05$), one could lean towards the idea that it is distraction, and not another effect of humor in itself, that underlies humorous tasks' impact on pain tolerance (Stuber et al., 2009).

However, other studies have found interesting results that grant certain validity to the biological theoretical frames. A comprehensive study carried out by Zweyer et al. (2004) observed that genuine enjoyment, expressed through the so-called Duchenne facial display (see Figure 2 for an example), is a mediator between watching a humorous film and changes in pain perception. The Duchenne display is a marker of amusement produced by the joint contraction of the zygomatic major and orbicularis oculi muscles, and can involve smiles as well as laughter (Ekman, Davidson, & Friesen, 1990). This display has been linked to feelings of amusement and the perceived funniness of humorous materials in a variety of studies (Hofmann et al., 2017). This study assessed the presence of the Duchenne display using the Facial Action Coding System, a comprehensive, anatomically based system for measuring all visually discernible facial movement (Ruch, 2005). Significantly, in this study the presence of forced laughter did not enhance the effect of the exposure to the humorous film, so, according to these findings, changes in pain perception would be produced if individuals enjoy themselves in an unrestrained manner, and not necessarily laughing at the film if it is not in an spontaneous way. In this regard, Dunbar et al. (2012) focused on what they called Duchenne laughter, which they defined as relaxed, unforced laughter that is stimulus-driven and emotionally valent. They observed significant effects on pain thresholds under both naturalistic and laboratory conditions, which the authors associated with endorphin release produced by the social laughter, something that has already been reported by other studies (Martin, 2010). However, originally Duchenne display, which may or may not include laughter, was defined by facial markers (i.e., the presence of the orbicularis oculi muscle), and can hardly be derived from solely study acoustics without further validation.

To sum up, it can be asserted that most studies reported a significant increase in pain tolerance after viewing a comedy clip, and not only in experimental conditions but also in real clinical settings (Lee & Uchiyama, 2015; Rotton & Shats, 1996). The effects seem to be related to the mechanism of distraction, as similar outcomes were reported for non-humorous but distracting tasks. However, some studies claimed that the endorphin release produced by social laughter may also be modulating pain tolerance. Notably, the findings seem to indicate that, to produce positive effects, the humorous stimuli need to match the individual's preferences and that being able to choose is an important part of the phenomenon. Moreover, trait seriousness, from the Ruch and Kohler model (1998), has been described to be negatively associated to pain tolerance (Zweyer et al., 2004). On the other hand, the numerous methodological shortcomings that most of the studies conducted to date have presented cannot be overlooked, such as small sample sizes, the non-systematic measurement of humor enjoyment, or the lack of variety of humoristic material that could adapt to a variety of preferences. Martin (2001) also considers that it would be necessary to measure pain threshold and tolerance over several assessments to obtain a more reliable score and to study how some emotional and cognitive variables may moderate the effect between humor enjoyment and pain tolerance.

3.2 Humor and chronic pain

Different theoretical accounts accord high relevance to the cognitive dimension of pain. For instance, the fear-avoidance model of pain (Crombez, Eccleston, Van Damme, Vlaeyen & Karoly, 2012; Vlaeyen & Linton, 2012) considers the meaning associated with the pain experience as a key aspect in the development of fear of pain and, therefore, avoidance behaviors. The process by which chronic pain leads to disability seems to be mediated by variables such as sensitivity to anxiety, fear of pain, catastrophism, and body vigilance (Crombez et al., 2012).

These cognitive variables are typical focuses of action for psychological interventions in chronic pain. Among the different therapeutic approaches, humor and laughter have been considered good tools to help patients with chronic pain (Behrouz et al., 2017; Weisenberg, 1994). Considering the relevance of psychological variables (e.g., anxiety, depression, life satisfaction, or distress) in chronic pain conditions, some of the findings regarding the effect of humor interventions on these aspects will be summarized below along with the results of the effects on pain itself.

Some studies assessed the generalized belief that humor is a good strategy for producing psychological improvements among patients with chronic pain; for instance, humor as a coping strategy is associated with lower levels of pain (Rotton & Shats, 1996) and with more effectiveness than pain-reduction therapies (Ferrell, Taylor, Grant, Fowler & Corbisiero, 1993). Similarly, Tse et al. (2010) observed significant therapeutic effects of humor therapy in reducing pain and loneliness ($p<$ .001), measured using the UCLA Revised Loneliness Scale (Russell, 1996), enhancing happiness, measured through the Subjective Happiness Scale (Lyubomirsky & Lepper, 1999) and life satisfaction, assessed using the Life Satisfaction Index-A (Neugarten, Havighurst & Tobin, 1961) in older people with chronic pain living in nursing homes (N=70). The intervention consisted of eight weekly one-hour group sessions. Patients were helped to design their own set of funny books, photos, jokes, audio and videotapes, comedy clips and cartoons; additionally, lectures on humor research were given and exercises to prioritize and use humor in their lives were practiced. Recently, Behrouz et al. (2017) observed a 43% decline in moderate pain intensity after a six-week humor therapy program in a sample of elderly people with chronic pain (N=56). In this case, the intervention consisted of 6, weekly, one-hour group sessions and included humorous video clips, games, comical stories, humorous music and jokes. These authors conclude that humor therapy can have an impact on pain intensity and, thus, it should be employed in social groups of elderly individuals such as those in nursing homes.

Some cross-sectional studies assessed humor-related variables in samples of patients with diverse medical conditions which present chronic pain. For instance, Hallberg and Carlsson (1998) found that the use of humor in a sample of 36 patients with fibromyalgia (FM) was associated with reduced anxiety (r= -.22, $p<$ .05) and greater ability to control pain (r= .33, $p<$ .01), and another study (Cuevas-Toro, Torrecillas, Medina, & Diaz-Batanero, 2008) found a significant association between humor use and positive reappraisal. Along the same lines, a more recent study (Fritz et al., 2017) concluded that humor was associated with less psychological distress at baseline ($\beta = -1.70$, $p<$ .01), and with fewer physical symptoms in both daily reports and at bedtime for patients with FM.

Another study (Galdón et al., 2006) assessed the use of humor as a coping strategy in a sample of patients with temporomandibular disorders (N=114) and observed that those who used humor less often tended to pay more attention to symptomatology and to present a poor ability to minimize their conditions (F= 2.58, p= .10). Later, Merz et al. (2009) found that humor coping strategies were associated with less pain (r= -.24, $p<$ .005), disability and distress outcomes (F= 11.21, R^2= .35, $p<$ .001) in a sample of 93 patients with systemic sclerosis, although the use of humor was not associated with disease severity.

Cancer is another pathology which often entails chronic pain; some authors have identified humor as an active component in pain management (Ferrell et al., 1993), as care-giving coupled with humor provided by nurses was considered more effective than care-giving with no humor involved. Similarly, Rose et al. (2013) observed that humor is an oft-used coping mechanism among women who suffer from recurrent ovarian cancer as it subjectively helps to alleviate anxiety. Leñero-Cirujano (2014) considered that humor is, because of its accessibility, effectiveness, non-invasiveness and price, a really helpful tool in healthcare for patients with cancer and their families. Her study offers a comprehensive explanation of how to determine the need for humor in patients with cancer and which objectives to pursue with this intervention from the nursing point of view. Bennett et al. (2014) reviewed the evidence related to laughter and humor therapy as a medical treatment for the dialysis-patient population and concluded that it could have applications in pain, among other symptoms (e.g., depression, fatigue, immunity, sleep quality, anxiety, respiratory function, and blood glucose).

Regarding the impact of different styles of sense of humor on pain and health, a study performed with a sample of retired people (Freeman & Ventis, 2010) observed that self-defeating humor was associated with more pain when daily hassles or stress were low; on the other hand, when stress and daily hassles were high, both self-defeating humor and aggressive humor were found to play an adaptive role (F= 10.70 for self-defeating humor; F= 17.92 for aggressive humor; p< .001 in both cases). Sánchez-Espinar et al. (2016) used the structural equation modeling analyses in a sample of 111 people with chronic pain, and found that self-enhancing humor and humor-based coping strategies were associated with higher life satisfaction and positive affect, but no significant link was found between these styles and perceived pain intensity. However, it should be pointed out that not all studies found positive outcomes for the effect of humor on chronic pain, as some found no association between humor coping strategies and psychological improvement (Merz et al., 2009). For instance, Leise (1993) studied sense of humor and chronic arthritic pain in a group of 30 women and observed that higher scores in sense of humor measures correlated positively and significantly with scores on the pain scale (r= .31, p< .01). The explanation given to this rare phenomenon was that perhaps the patients with higher pain needed to use more sense of humor to cope with it.

In summary, the use of humor has been studied as a form of coping with symptoms derived from chronic pain conditions with relatively positive outcomes as, according to the findings of the experimental studies reviewed, improvements have been reported for levels of pain and the effectiveness of pain-reduction interventions (Behrouz et al., 2017; Tse et al., 2010). Moreover, the studies found interesting links between use of humor and lower levels of anxiety, daily stress, and loneliness, among other variables (Bennett et al., 2014; Cuevas-Toro et al., 2008; Merz et al., 2009;

Tse et al., 2010). We can conclude that more studies are needed, not only to study the association between humor and different relevant variables in chronic pain conditions, but also to determine the effectiveness of humorous interventions to cope with the symptoms. In addition, and for the sake of a better understanding of the use of humor as a therapeutic tool for treating chronic pain, standardized programs and a consensus over the assessment tools would be recommendable.

3.3 Humor and pain in children

Children constitute a population exposed to pain in its different forms (Evans, Tsao & Zeltzer, 2008): acute pain may appear after medical interventions as well as the consequence of common childhood misfortunes such as playground injuries; and chronic pain can also affect children who suffer from some medical conditions (e.g., cancer, juvenile arthritis) or just some painful symptoms (e.g., migraines, abdominal pain, limb pain). Studies conducted on this topic have been performed both in the hospital context and in the laboratory, and have assessed the influence of humorous distractions such as watching funny clips or the effectiveness of clinic clown interventions.

Regarding experimental pain, laboratory evidence for laughter and humor is encouraging. A pilot study (Stuber et al., 2009) using the CPT and evaluating pain tolerance and intensity, laughter and smile rating, and subjective humor rating, found that watching humorous videos increased tolerance of a moderately painful stimulus (F= 9.63, p= .02). The authors judged this result to be robust enough to be considered significant and clinically useful although the sample was small (N=18). Interestingly, although tolerance increased when watching the humorous clip, the pain severity appraisal did not change. The number of laughs was associated with neither pain tolerance nor pain severity. Previous studies conducted with adults suggest that the increase in pain tolerance is due to an emotional distraction and not to the humorous factor (Elmali & Balci Akpinar, 2017; Mitchell et al., 2006; Weaver & Zillmann, 1994; Weisenberg, Tepper, & Schwarzwald, 1995; Zillmann et al., 1993), but in children it is ethically untenable to carry out such an experiment in which kids in pain are exposed to sad or scary videos. The results of this pilot study suggest that practicing humor with kids who are in pain can be effective, whether or not they laugh out loud.

In the hospital context, humor interventions are frequently delivered in the form of clinic clown interventions (Felluga et al., 2016; Gilboa-Negari, Abu-Kaf, Huss, Hain, & Moser, 2017). Medical clowning uses laughter therapy and humor to alleviate the emotional and physical difficulties of patients and their families. Clowns use techniques such as magic tricks, gags, games, soap bubbles,

dance, songs, stories or non-verbal scenes according to the children's age and medical condition (Mortamet et al., 2017). The findings regarding the effectiveness of clinic clown interventions over pain are not sound, as some the studies do not report a significant decrease in this variable (Felluga et al., 2016; Hansen, Kibaek, Martinussen, Kragh, & Hejl, 2011; Wolyniez et al., 2013). However, medical clowning has proved to be effective in reducing pain-related aspects such as anxiety and stress for both children and their parents (Gilboa-Negari et al., 2017; Golan, Tighe, Dobija, Perel, & Keidan, 2009; Goldberg et al., 2014; Meiri, Ankri, Hamad-Saied, Konopnicki, & Pillar, 2016).

Also in the hospital context, a cross-sectional study (Goodenough & Ford, 2005) observed that children who scored relatively high on use of humor as a specific strategy for dealing with pain tended to have direct problem-focused pain-coping styles such as approach (e.g., information seeking, problem-solving, positive self-talk) and distraction (r= .54 to .70, p< .001). Notably, these authors do not recommend using humor with highly anxious children, as they may find it dismissive or anxiety enhancing. Moreover, in a qualitative study conducted in a sample of children who were hospitalized in an acute paediatric unit and their families, Ford, Courtney-Pratt, Tesch & Johnson (2014) observed that the impact produced by the clown doctors' visits was experienced beyond the immediate interaction, as children experienced anticipation and excitement before visits and sometimes the laughter continued once the clown doctors had left.

Knowledge on the effect of humor on children with chronic pain, on the other hand, is scant. As in the case of adults, chronic pain conditions in children present a range of symptoms in which emotional distress plays an important role and it is for this reason that humor is considered a useful approach in children who are dealing with chronic conditions and pain. Some studies have observed that clinic clown interventions for children with chronic illnesses can provide reassurance, relaxation and enhanced trust between the clown and the child (Oppenheim, Simonds, & Hartmann, 1997). Developing humor as a coping mechanism encourages children to adopt a positive perspective and understanding of the difficult situations they are going through (Kuiper, Grimshaw, & Leite, 2004). At the same time, using humor (whether producing or enjoying it) relieves feelings of tension, intimidation and anger, preventing and reducing the development of behavioral problems (Kim & Yeon, 2003). Furthermore, the positive effects of humor as a coping strategy on resilience encourage vulnerable patients with chronic diseases to build positive thinking, which becomes a defense mechanism when facing problems (Rew & Horner, 2003). In this regard, Sim (2015) found that 6, one-hour, weekly humorous sessions could significantly improve resilience among children (t= 2.99, p= .005). The materials for the humor intervention included humorous videos, humor games, comic stories, humorous music, and joke cards.

In brief, according to the experimental studies conducted on the subject, children respond similarly to adults in the sense of increasing their pain tolerance while being exposed to a humorous distraction, and clinic clown interventions offer a set of benefits in terms of emotional wellbeing, although their effectiveness on pain is still in doubt due to the divergent findings. However, these results must be considered carefully due to the scarceness of good forms of evaluating humor in children (Goodenough & Ford, 2005). To our knowledge, no studies have been conducted on the effect of humor on chronic pain conditions in children, although findings related to its effects on other chronic illnesses suggest that humorous interventions may be beneficial for different outcomes including pain. For further studies, it would be valuable to identify the characteristics of effective humorous interventions for children, as different approaches have been used to date.

4. Conclusions and future directions

The studies reviewed here allow us to conclude that humor can influence not only pain tolerance and pain threshold but also pain-related variables such as anxiety, stress, loneliness and life-satisfaction, among others. In the case of experimental pain, the exposition to a humorous clip or audiotape while going through a painful procedure such as the CPT has been proved to increase pain tolerance both for adults and children. The funniness attributed to the humorous stimuli plays an important role in the effect, which can even be negative if the stimulus is considered not funny (Rotton & Shats, 1996). These results highlight the rellevance of assessing humor styles and allowing the participant (or patient, in the clinical context) to choose the humorous tape to which be exposed. For what concerns to chronic pain, humor interventions have presented some promising evidence of effectiveness in reducing pain (Behrouz et al., 2017; Tse et al., 2010) and associated symptoms in the case of adults; for children, humor has not been studied in chronic pain conditions, but it has been in other chronic conditions as a coping strategy related to resilience. Special mention is required for clinic clown interventions, which have presented very promising results in decreasing stress both for children and families in the hospital context.

However, the knowledge accumulated does not allow to conclude which are the mechanisms underlying the link between humor and pain. Many studies seem to indicate that distraction is the responsible for the effect (Elmali & Balci Akpinar, 2017; Mitchell et al., 2006; Weaver & Zillmann, 1994; Weisenberg et al., 1995; Zillmann et al., 1993), but some others have claimed the endorphin release produced by the social laughter can be an important modulator of pain perception (Dunbar et al., 2012; Manninen, et al., 2017). The biological frames have been granted little attention ever since some studies did not find any changes in beta-endorphins when being exposed to a humorous clip

(Berk et al., 1989; Itami, Nobori, & Teshima, 1994), but these studies should be replicated with modern methods and larger samples. A possible explanation to combine both biological and psychological perspectives would be that, while distraction in itself is capable of increasing the pain threshold and pain tolerance, a more powerful mechanism such as the endorphin release produced by genuine amusement is needed to improve psychological wellbeing. Nonetheless, studies are required to prove this hypothesis.

Despite the great academic and clinical relevance that the studies reviewed have achieved, the field of humor and pain is still on its infancy. As mentioned in the introduction, humor and sense of humor are complex concepts which involve different cognitive, affective, social and physiological processes. That is probably the central difficulty that hinders the methodological rigor and, thus, the comparison between studies (see Supplementary Table). To overcome this limitation, Martin (2004) considered that it is indispensable to adjust the research design and specify the type of questions that demand answers and the ways humor will be managed and measured, as well as the health-related variables that will be assessed. Following these recommendations, which have been summarized in Table 1 next to some others that have been considered relevant, would be one way of improving the quality of the studies. These suggestions are not only useful for designing proper studies but also for developing strong psychometric measures to assess humor, which are particularly scarce in the case of children in pain (Goodenough & Ford, 2005). On the other hand, cross-sectional studies could focus on finding more significant correlations between sense of humor and psychological aspects; these could be then studied in experimental studies as mediators or moderators of the effect of humorous interventions over pain perception or pain-related aspects such as quality of life or well-being. We would like to underline the importance of finding a consensus regarding the assessment of the response to the humorous stimuli, as while some studies have focused on objective indicators such as the Duchenne facial display or the number of laughs during the exposure, others have assessed it using a questionnaires; this hinders the unification of results and, thus, the extraction of sounder conclusions. Finally, and as commented previously, designing standardized programs which could be adapted to different senses of humor would be a great step in this field.

Many questions regarding the effect of humor on pain remain unanswered (see Stuber et al., 2009): would passive humor (e.g., watching a humorous clip) be more or less effective than active or interactive humor (e.g., telling jokes)? Would a live humorous performance such as clown-therapy be more effective than watching a funny clip on a screen? Are there other personality traits, besides bad mood and seriousness (Ruch & Hofmann, 2012), which may moderate the effect of humor over pain? Can other psychological variables (e.g.: catastrophism, negative affect) moderate this effect? And

regarding children, do they all find the same material funny? Questioning the role of culture in the relation between pain and humor is another interesting topic which has not been explored yet, although some studies (Kazarian & Martin, 2004, 2006) have reported differences among the use of humor associated to health in different cultures (Armenian, Canadian, and Belgian), and relevant patterns of correlations between humor styles and the culture-related personality dimensions of individualism and collectivism: for instance, individuals who endorse a vertical individualism perspective are more likely to use an aggressive style of humor, while cultures endorsed to a horizontal collectivist perspective tend to engage in affiliative humor, which is in turn associated to a higher degree of well-being. Altogether, these preliminary findings and unanswered questions draw a path for future researchers who want to contribute to the understanding of humor's link with pain and its implementation in clinical contexts.

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Author contributions

APA: Literature search, figures and tables, study design, writing. JH: Figures and tables, writing. AFS, LAR and JVL: Study design, writing. CRM and WB: writing.

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Legends for illustrations and tables

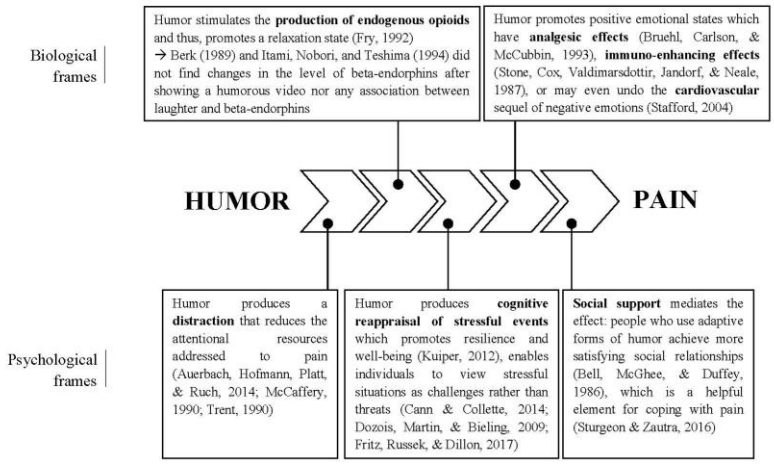
Figure 1. Theoretical frames on humor's effect on pain

Figure 2. Example of the Duchenne display

Table 1. Check List for Future Studies

Topic	Description	Suggested Reading
Theory Building and Hypotheses		
1. Humor	Choose model that is suitable for your purposes (are you looking at individual differences; humor production, humor appreciation?)	Ruch (2007): edited volume on "the sense of humor: explorations of a personality characteristic" Ford (forthcoming): overview book on "the psychology of humor" Ruch & Hofmann (2012): overview chapter on "humor" in the Oxford Online Encyclopedia
	Do you look at "humor" as a trait (leading to a quasi-experimental design) or "humor" as a stimulus/intervention (leading to an experimental design)	
2. Pain	Which aspects of pain are you looking at? (chronic vs. acute vs. induced pain)	Grichnik, K.P. & Ferrante, F.M. (1991). The difference between acute and chronic pain. *The Mount Sinai Journal of Medicine, 58*(3), 217-220.
Design		
3. Setting	Are you opting for a controlled laboratory setting where pain is induced or a more ecologically valid setting?	
4. Grouping	Do you apply an experimental or quasi experimental design (i.e., grouping individuals according to their sense of humor into groups of "high" vs. "low sense of humor")	
5. Comparison Groups	Do you include control or comparison groups? Are the "treatments" comparison groups receive appropriate? Ethical considerations?	
6. Confounds	Do you expect any error or confounder?	
	Consider gelotophobia (the fear of being laughed at): Gelotophobes may distort your results	Ruch et al. (2014): overview article on gelotophobia
	Consider trait bad mood and trait seriousness: Individuals with high scores on either trait have heightened thresholds for the induction of amusement	Ruch & Hofmann (2012): overview article on the state-trait model of cheerfulness, seriousness and bad mood

	Context: Is the situation, context favorable for the elicitation of amusement?	Deckers (2005): Overview chapter on the effect of mood on the induction of amusement
7. Dependent Variables	What are your outcome measures? How do you assess the induction of amusement? With subjective or objective data (e.g., self-reports or facial measurement of amusement)? Problems with social desirability in self-reports?	Rosenberg & Ekman (forthcoming): edited volume on "what the face reveals: basic and applied studies with the Facial Action Coding System"
Methods		
8. Humor Stimuli	What kind of stimuli do you use to induce amusement? Jokes, cartoons, movies, humor interventions (training or clowns)? Will the stimuli be funny for your specific group under investigation (will the stimuli match their humor taste?)	Ruch & Hofmann (2017): overview chapter on "fostering humor" Ruch, W. & Hehl, F.J. (1998). A two-mode model of humor appreciation: Its relation to aesthetic appreciation and simplicity-complexity of personality. In: W. Ruch (Ed.), *The sense of humor: Explorations of a personality characteristic.* Berlin: Mouton de Gruyter, 109-142. Craik, K. H., Lampert, M. D., & Nelson, A. (1996). Sense of humor and styles of everyday humorous conduct. *Humor: International Journal of Humor Research, 9*(3–4), 273–302. DOI: 10.1515/humr.1996.9.3-4.273
Analyses		
9. Units of analyses	Which units do you analyze? Do you aggregate data?	Ruch, W. (1995). Will the real relationship between facial expression and affective experience please stand up: The case of exhilaration. *Cognition and Emotion, 9*, 33–58. doi:10.1080/02699939508408964
10. Data distortion and manipulation check	Have you omitted data of gelotophobes? Did you check the power of the humor induction (i.e., was the amusement induction successful? Did individuals find the stimuli funny?)	



Note. Left-hand photo: Neutral face. Right-hand photo: Duchenne display, produced by the joint contraction of the zygomatic major and orbicularis oculi muscles. The muscular contraction usually lasts from 0.5 to 5 seconds
(Ruch, 2005).